REINFORCED CONCRETE RAILWAY TRESTLE

BY

T. F. WOLFE

ARMOUR INSTITUTE OF TECHNOLOGY

1912

THESIS

DESIGN OF A STANDARD

REINFORCED CONCRETE

RAILWAY TRESTLE.

Presented by

Thomas F. Wolfe

to the

PRESIDENT AND FACULTY

of

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in

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1912

Approved: Alfred E. Phillips
Prof Civil Engineering

H. M. Raymond
Dean of Eng. Studies

L. C. Monin.
Dean of Cult. Studies.

DESIGN OF A STANDARD

REINFORCED CONCRETE

RAILWAY TRESTLE.

PREPARED AS A

GRADUATION THESIS

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THOMAS F. WOLFE

A. I. T.

CHICAGO, ILL.

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CONTENTS

THE DESIGN OF A STANDARD REINFORCED CONCRETE RAILWAY TRESTLE

In railway construction numerous places are encountered where fills are prohibitive because of the nature of the ground, and where long span bridges would be too expensive to use. This is true of boggy land, swamps, river bottoms, and such places where there is no flow of water to speak of, but where fills would be undesirable. In these locations, since there is neither floating ice nor drifting material to look out for, there is no objection to the large number of supports necessary in trestles. For these reasons trestles have been used since the earliest days of railroad construction. Up to a comparatively few years ago wood was used exclusively for this class of structure, but it is now being replaced by steel and concrete.

For extremely high structures steel is used, while for all other structures concrete is most adaptable. The general design of the concrete structure follows closely the general lines of the old wooden one. Spans of from fifteen to twenty feet are used, supported either on piers, or on pile bents. The pile bents used, are practically a duplicate of the wooden ones, but are entirely of reinforced concrete; they are used where the height of the structure is not so great as to cause excessive bending in the supports. In cases where bending does take place thin piers are substitut-

ed for the pile bents. The use of the thin piers makes it more economical to use larger spans than are used with pile bents, so in the following work a twenty-two foot slab has been designed for this type. The great advantage of the pile bent type is the fact that it reduces the field work to a minimum, since both the slabs and piles are cast at some central yard, leaving only the pile caps to be cast at the bridge site. In the following work the complete figures are shown for the design of each part of the trestle as well as the drawings of each part and of the entire structure. The last plate shows in detail the material necessary for the various parts of the trestle.

DATA

LOADING:-Live load--Coopers E 50

Dead load--Weight of slab, ballast, and track.

Concrete=150#	per cu. Ft.	
Ballast =100#	" " "	
Track =150#	" lineal Ft.	
Timber = 4 1/2#	" board Ft.	

SPECIFICATIONS:-American Railway Engineering and Maintenance of Way Association.

SPANS:- 15, 16, 17 and 22 Feet.

Considering a depth of 6" of ballast under the tie and a tie 8x10x10-0, the dead weight per foot of bridge is as follows:

Wt. of 1 tie	= 300#
" " 8 cu. Ft. of ballast	= 800#
" " 1 Ft. of track	= 150#
Total wt. per ft.	=1250#

Since the width of slab is 14'-0" the dead load per sq. ft. of bridge=1250 ÷ 14 =90

STRESSES IN SLABS

A.-15 ft. Span:- Live load bending moment per rail=1,878,000 inch pounds.

This moment is distributed over 7 feet of slab, therefore the bending moment taken by 1 foot$=\frac{1,878,000}{7}=$268,300 in. lbs.

Assume weight of slab to be 300 lbs. per sq. ft.

Dead load bending moment$=\frac{390\times15^2\times12}{8}=$131,800 in. lbs.

Impact $=268,300\frac{300}{300+15}=256,000$ in. lbs.

Total bending moment $=656,100$ in. lbs.

Maximum live load end shear per rail $=50,000$#

Impact per rail $=50,000\ \frac{300}{315}=47,700$#

Dead load shear per foot of width $=2920$#

In the following discussion the following symbols will be used.

M_1 = Live load bending moment per rail

I = Impact " " " "

M_d = Dead load " " " "

R_1 = Live load shear " "

I_s = Impact " " "

R_d = Dead load " " "

M = Total bending moment

S = Total Shear

M_1', I', M_d', R_1', I_s' and R_d', refer to the same stresses per foot of width.

B.-16ft. SPAN:- $M_1=2,100,000$ in lbs.

$I=2,000,000$ in lbs.

$M_1'=300,000$ in lbs.

$I'=285,700$ in lbs.

$M_p'=\frac{390\times16^2\times12}{8}=150,000$ in.lbs.

$M'=735,700$ in. lbs.

$R_1=53,100$#

$R_1'=7,590$#

$I_s'=7,200$#

$R_d'=390\times8=3,120$#

$S'=R_d'\ I_s'\ R_1'=17,910$#

C.--17ft. SPAN:- M_1=2,320,000 in. lbs.

M_1'=391,400 In. lbs.

I' =313,500 in. lbs.

M_d'=169,000 in. lbs.

M' =813,900 in Lbs.

R_1 = 55,900 #

R_1'= 8,000#

I_s'= 7,570#

R_d'= 3,310#

S '= 18,880#

D.--22ft. SPAN:- Assume thickness of slab of 2ft. 8 in.

M_1= 3,690,000 in Lbs.

M_1'=527,150 in. lbs.

I'=492,000 in. lbs.

M_d'=356,000 in. lbs.

M'=1,375,150 in. lbs.

R_1= 66,000#

R_1'=9,450#

I_s'=8,800#

R_d'=5,390#

S'=23,620#

DESIGN OF SLABS

In all the following work the symbols used by Turneaure and Maurer are used.

n=15 fs=15000# fc=750#

$$\frac{fs}{nfc} = \frac{1-k}{k}$$

$\frac{15000}{15x750} = \frac{1-k}{k} = 1.333$

K $= .428$

J $= 1-1/3k = .857$

M_s $= F_s\ Adj$

A $= \frac{Ms}{Fs\ jd}$

Mc $= 1/2Fc\ Kj\ bd^2$

Fc $= \frac{2Mc}{Kj\ bd^2}$

A.--15ft. SLAB:--D.=23-2 1/2=20 1/2 in.

M=656,100 in. lbs.

$A = \frac{656,100}{15000x\ .857x20.5} = 2.50$ sq. in.

$Fc = \frac{2x656,100}{.428x.857x12x20.5^2} = 708\#$

Use 7/8 sq. in. bars spaced 3 1/2" centers.

B.--16ft. SLAB:--D.=24-2 1/2=21 1/2 in.

M-735,700 in.lbs.

$A = \frac{735,700}{15000x.857x21.5} = 2.66$

$Fc - \frac{2x735,700}{.428x857x12x21.5^2} = 722\#$

Use 7/8 in. sq. bars at 3 1/2 in. centers.

C.--17ft. SLAB:--D. =25-2 1/2=22 1/2 in.

M=813,900 in. lbs.

$A = \frac{813,900}{15000x.857x22.5} = 2.82$ sq. in.

$Fc = \frac{2x813,900}{.428x857x12x22.5^2} = 729\#$

Use 7/8 in. sq. at 3" centers.

D.--22ft. SLAB:- $D=32-3=29$ in.

$M=1,375,150$ in. lbs.

$$A=\frac{1,375,150}{15000x.857x29}=3.7\_ \text{ sq. in.}$$

$$Fc=\frac{2x1,375,150}{.428x857x12x29^2}=742\#$$

Use 1 in. round bars at 2 1/2 in. centers.

The following diagrams show where rods should be turned up to resist shear. No stirrups are needed.

LIFTING STIRRUPS

Weight of 22 foot slab$=\frac{32}{12}$ x7x22x150=61,700#

$\frac{61,700}{15000}=4.1$ sq. in. =area of stirrup.

Use 2 stirrups 1 5/8 in. round.

Weight of 1-17foot slab$=\frac{26}{12}$ x7x17x150=37,300

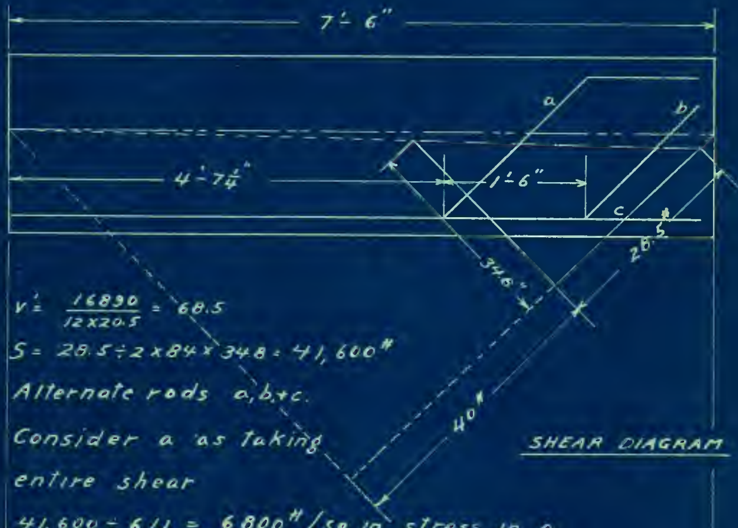
$\frac{37,300}{15,000}=2.49$ sq. in.

Use 2 stirrups 1 1/2 in. round.

15'-0" SLAB

WIDTH 7'-0" DEPTH 23" DEPTH TO STEEL $20\frac{1}{2}$"

STEEL $\frac{7}{8}$" □ BARS $3\frac{1}{2}$" C. TO C.



$v = \dfrac{16890}{12 \times 20.5} = 68.5$

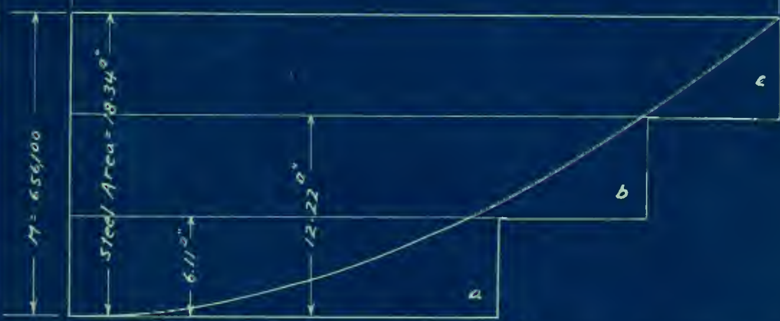
$S = 28.5 \div 2 \times 84 \times 34.8 = 41{,}600$#

Alternate rods a, b, + c.

Consider a as taking entire shear

41,600 ÷ 611 = 6800#/sq. in. stress in a.

SHEAR DIAGRAM

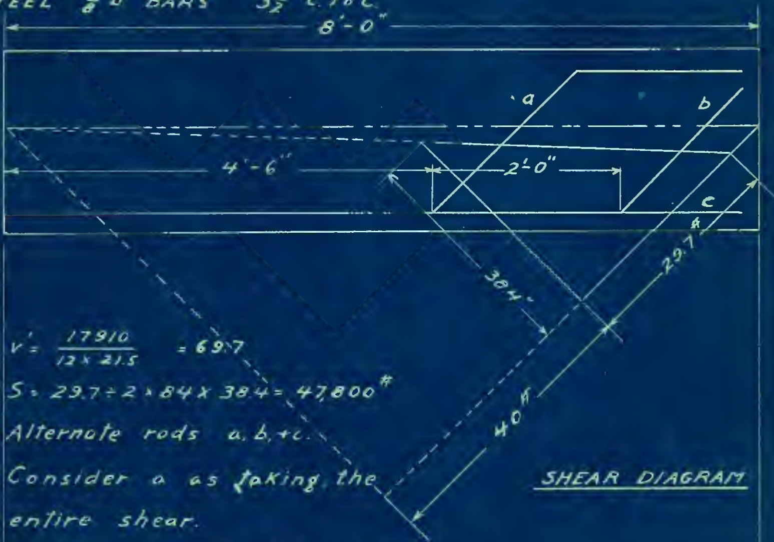


MOMENT DIAGRAM

16'-0" SLAB

WIDTH 7'-0"   DEPTH 24"   DEPTH TO STEEL $21\frac{1}{2}$"

STEEL $\frac{7}{8}$" ⌀ BARS $3\frac{1}{2}$" C. TO C.



$v' = \frac{17910}{12 \times 21.5} = 69.7$

$S = 29.7 \div 2 \times 84 \times 38.4 = 47,800$#

Alternate rods a, b, + c.

Consider a as taking the entire shear.

$47,800 \div 6.11 = 7850$#/sq. in. stress in a.

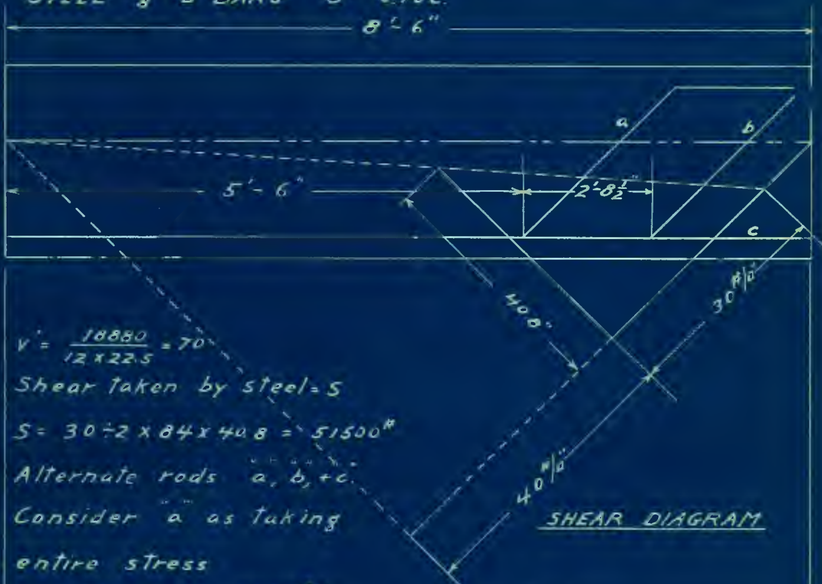
SHEAR DIAGRAM

MOMENT DIAGRAM

17'-0" SLAB

WIDTH 7'-0" DEPTH 25" DEPTH TO STEEL $22\frac{1}{2}$"

STEEL $\frac{7}{8}$" □ BARS 3" C TO C.



$V' = \frac{18880}{12 \times 22.5} = 70$"

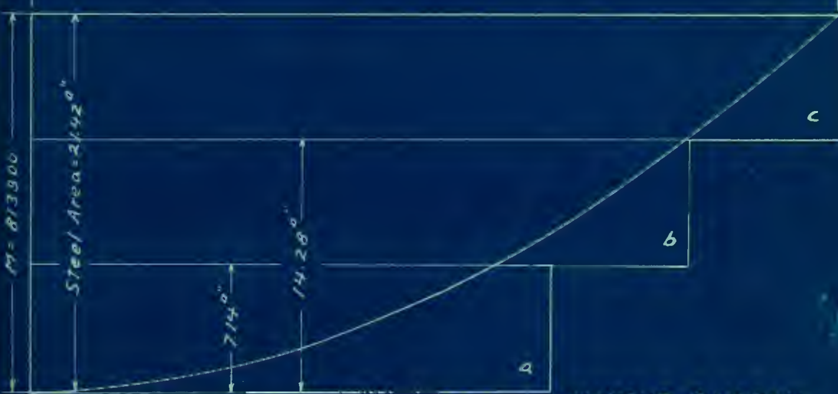
Shear taken by steel = S

S = 30 ÷ 2 × 84 × 40.8 = 51500#

Alternate rods "a, b, + c."

Consider "a" as taking entire stress

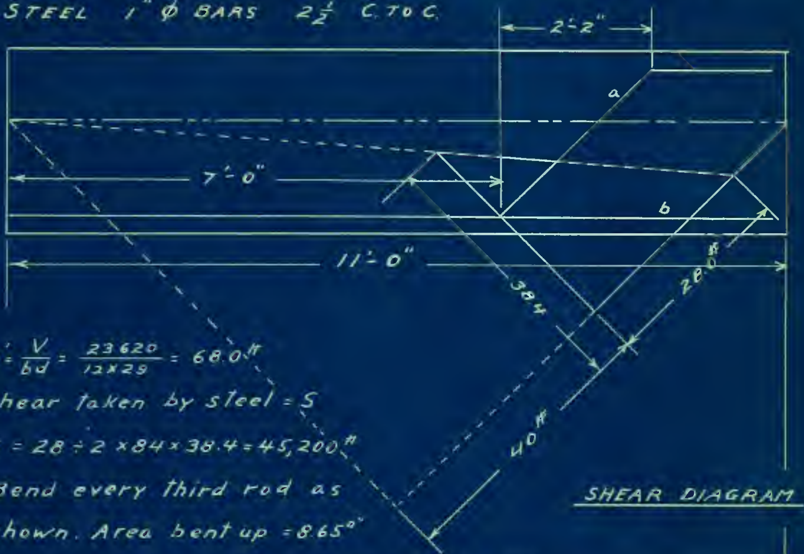
51,500 ÷ 7.14 = 7230#/sq. in stress in a.



22'-0" SLAB

WIDTH 7'-0"   DEPTH 32"   DEPTH TO STEEL 29"

STEEL 1" ϕ BARS $2\frac{1}{2}$" C. TO C.



$v' = \frac{V}{bd} = \frac{23620}{12 \times 29} = 68.0$#

Shear taken by steel = S

S = 28 ÷ 2 × 84 × 38.4 = 45,200#

Bend every third rod as shown. Area bent up = 8.65□"

45,200 ÷ 8.65 = 5230#/sq. in stress in steel

DESIGN OF PILE BENT

The maximum live load reaction at any bent supporting two 17 foot slabs is 147,200#. The dead load reaction = 390x17x14=92,500# The total reaction=147,200+92,500 = 239,700# While this is the reaction for seventeen foot spans it will be used in designing the bents for all spans.

In the absence of any knowledge of the soil conditions at the trestle a pile will be considered as carrying a load of only twenty tons. This value is low enough to allow for the most unfavorable conditions.

$$239{,}700 \div 40{,}000 = 5.99$$

Therefore 6 piles will be used in each bent, each one fourteen inches square.

Area of pile =196 sq. in.

$\frac{40{,}000}{196} = 204\#$ per sq. in. compression on pile. This value is well within the required limit.

In designing the pile cap we will assume that one pile has settled or failed, causing the cap to act as a continuous beam over a span of four feet six inches(see blue print)

Live load reaction=147,200#

Dead " " = 92,500#

Total " " =239,700#

Reaction per foot =17,100#

Weight of cap per foot=1,000#

Total weight " " =18,100#

$$M = \frac{w\,l^2}{12} = \frac{18100 \times 54^2}{12} = 4{,}440{,}000 \text{ in. lbs.}$$

$K=.428$ $\qquad j=.857$ $\qquad d=31$ in.

$$A=\frac{4,440,000}{15000\times.857\times31}=11.00 \text{ sq. in.}$$

$$Fc=\frac{2\times4,440,000}{15000\times.857\times28\times31^2}=890\#$$

This stress must be reduced to 750# by using compressive steel.

Area of tensile steel=1.30%

Allowed concrete stress=750#

Per cent reduction $\frac{890-750}{890}=15.8\ \%$

From table 12 Turneaure and Maurer we find that .52% of compressive steel is needed to cause the reduction.

$.0052\times28\times31=4.53$ sq. in.

Use 9--1 in. square bars in bottom of cap

Use 5--1 in. " " at top " "

Maximum shear=18,100x2.25=40,700#

$$\frac{40,700}{28\times31}=47.0\# \text{ shear}$$

Since this value is within the allowed value for concrete, no steel is needed to resist the shear.

Double pile caps will be used for every fifth bent. About 1 1/2 times as much steel will be used as in the other caps.

DESIGN OF PIER

When the distance from base of rail to the ground exceeds sixteen feet, thin piers will be used instead of pile bents. For slabs with a twenty-two foot span, piers will be used in all cases. The pier will be designed for a twenty two foot span and the same section used for all other spans. The stresses that the pier must resis consist of direct compression, due to the weight of the structure and load, and bending moment, due to the stopping of a train on the trestle. The use of an expansion joint at each pier eliminates bending due to the expansion and contraction of the slabs, and the fact that thin piers are used reduces the wind and current stresses to a negligible quantity.

Weight of 22ft. span =116,500#

" " pier about 67,000#

Maximum pier reaction=175,400#

Total load on pier =358,900#

Pier cross section =24 in. x 168 in.

358,900÷40,000=9 piles needed.

358,900÷(24x169)=130# compression.

Maximum load in one panel due to uniform train load = 22x5000=110,000#

Force acting at top of rail due to stopping of train= 1/5x110,000=22,000#

Since the height of pier varies we will assume an extreme case in designing the steel to resist bending. Assume a height of twenty feet to rail top.

$$M = 22000 \times 20 \times 12 = 5{,}270{,}000 \text{ in. lbs.}$$

$$A = \frac{5{,}270{,}000}{15000 \times .857 \times 21} = 19.5 \text{ sq. in.}$$

$$Fc = \frac{2 \times 5{,}270{,}000}{.428 \times .857 \times 14 \times 12 \times 21^2} = 384\#$$

Use 20 one inch square bars spaced uniformly across the pier.

PIER FOOTING

Assume a depth of footing of 42 inches and a depth to steel of 32 inches.

Area of section resisting shears=

$$2 \times 32 \times 168 = 10{,}740 \text{ sq. in.}$$

$$358{,}900 \div 10740 = 33.4\# \text{ per sq. in.}$$

$$M = \frac{358{,}900}{2} \times 18 = 3{,}230{,}000 \text{ in. lbs.}$$

$$A = \frac{3{,}230{,}000}{15000 \times .857 \times 32} = 7.85 \text{ sq. in.}$$

Use 14-3/4 in. square bars.

$$Fc = \frac{2 \times 2{,}230{,}000}{.428 \times 857 \times 14 \times 12 \times 32^2} = 103\#$$

DESIGN OF ABUTMENT

The abutment shown on plate 1 will be used in all cases. We will consider a surcharge of five feet and figure the earth pressure at the various depths. The stability of the abutment is determined on plate 1 using the following figures for earth pressures and weights.

p=.3x120x16.33=588#

p=.3x120x8.80 =317#

$P = \frac{317\ 588}{2} \times 12.5 = 5000\#$

This pressure P acts at a distance of 11 feet from the bottom of the footing.

Wt. of 1 ft. of front wall	=5840#
" " " " " earth A	=3080#
" " 2 side walls	=45000#
" " 2 " " per ft.=	
of abutment face	=3220#
Dead load reaction from	15ft slab =2900#

All these forces are shown acting at their respective points of application in plate 1. They are combined graphically and the resultant R is found to fall within the middle third.

The vertical component of this resultant is 14720#

Total dead load on abutment =14720x14-206,000#

Live load reaction-132,000#

Total load on abutment piles=338,000#

338,000 ÷ 40,000=10 nearly.

Use 10 piles in abutment.

Consider part of side walls to left of lines BB (see diagram.) to be supported by the diaphram.

Pressure at top $= .3\times120\times5 = 180\#$

" " bottom $= 3\times120\times17.8 = 642\#$

Total pressure $= \frac{180\ 642}{2}\ (6\times6.75\ \frac{6\times6}{2}) = 240000\#$

Total tension taken by steel $= 48000\#$

$48000 \div 15000 = 3.20$ sq. in. needed.

Use 14-1/2 in. rods.

Consider the part of wall between the diaphram and the front wall to act as a simple resisting horizontal earth pressures. At the bottom the pressure per square foot is 216#

$$M = \frac{w\ l^2}{8} = \frac{216\times8^2\times12}{8} = 20,700 \text{ in. lbs.}$$

$d = 18-3 = 15$ in.

$$A = \frac{20700}{15000\times.857\times\cancel{12}\times15} = .107 \text{ sq. in. per ft.}$$

$$Fc = \frac{2\times20700}{.428\times.857\times12\times15^2} = 417\#$$

Use 1/2" square bars at 10 inch centers.

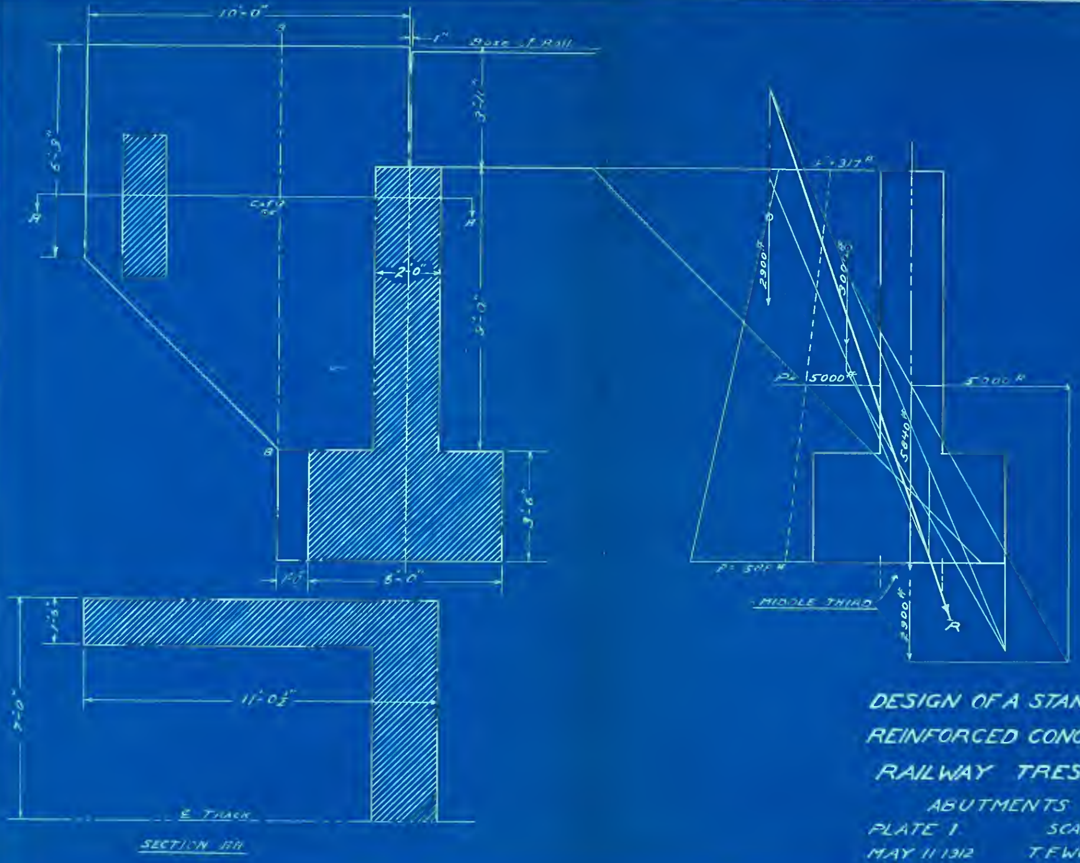
The pressure at the bottom of the front wall is 432# per square foot.

$$M = \frac{w\ l^2}{8} = \frac{432\times14^2\times12}{8} = 127000 \text{ in. lbs.}$$

$$A = \frac{2\times127000}{.428\times.857\times12\times21^2} = 131\# \text{ per sq. in.}$$

Use 3/4" square bars at 14 inch centers.

In addition to the steel figured above other rods are used for the purpose of holding the reinforcement in place as well as to take care of smaller and less important stresses.

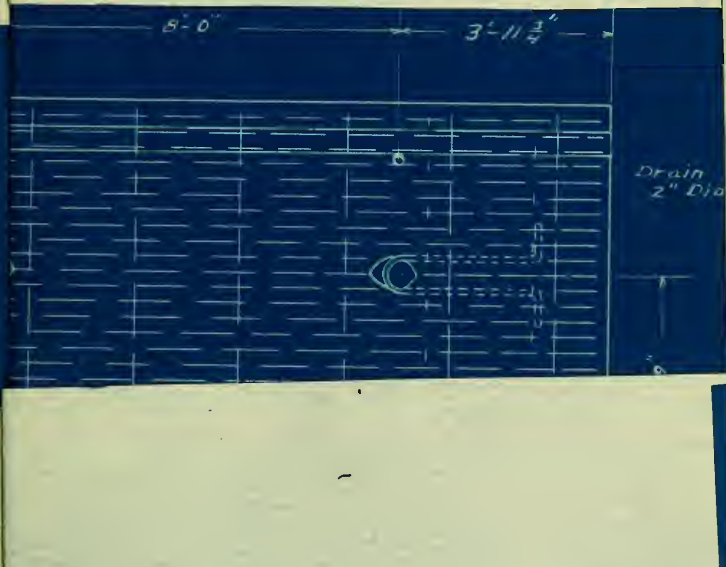


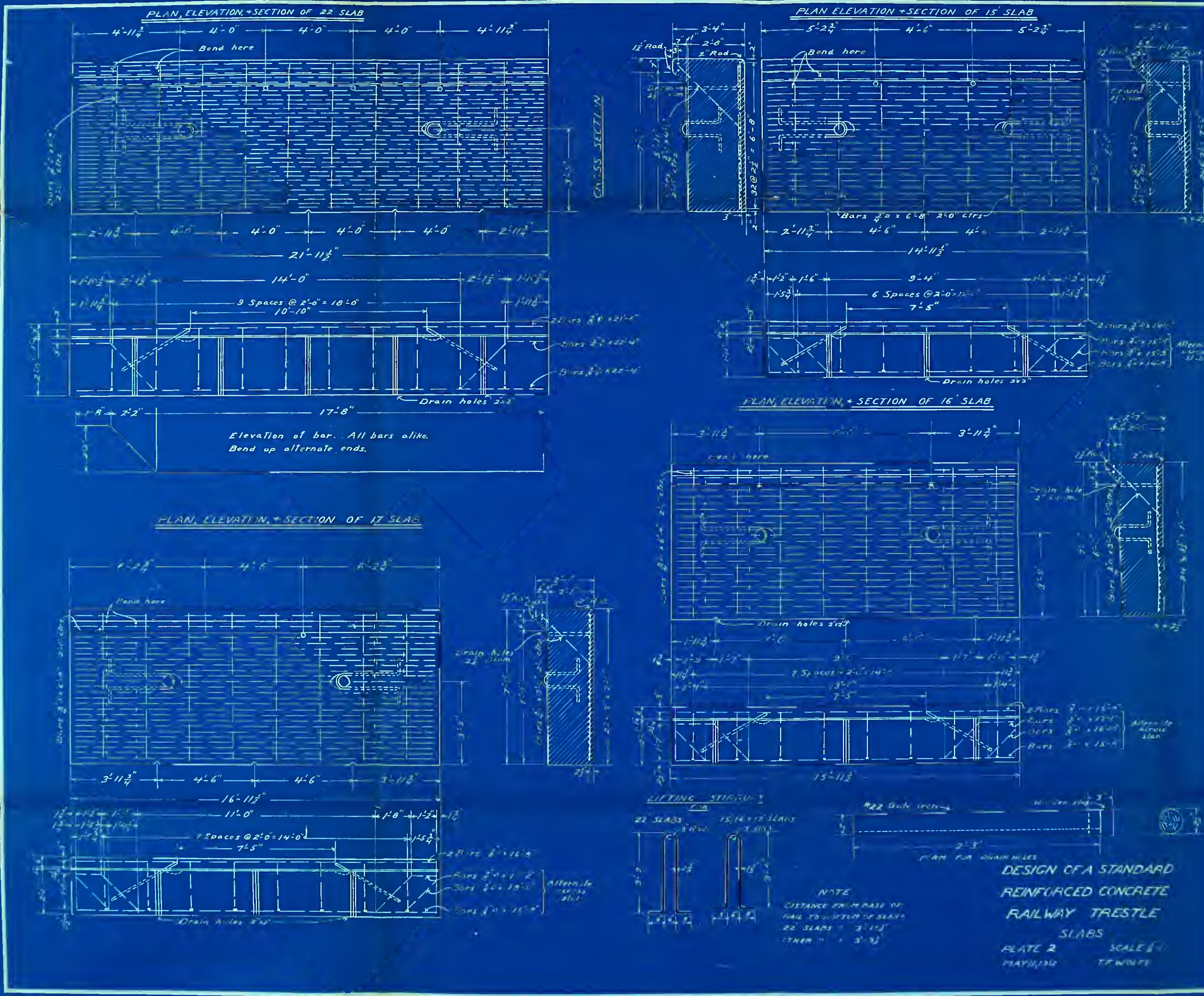
DESIGN OF A STANDARD
REINFORCED CONCRETE
RAILWAY TRESTLE

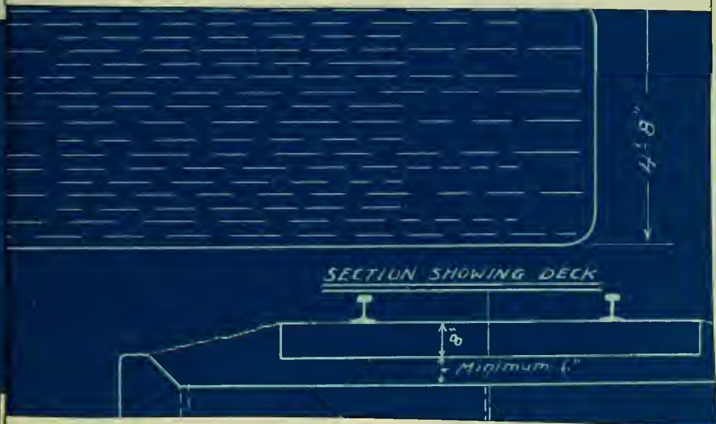
ABUTMENTS

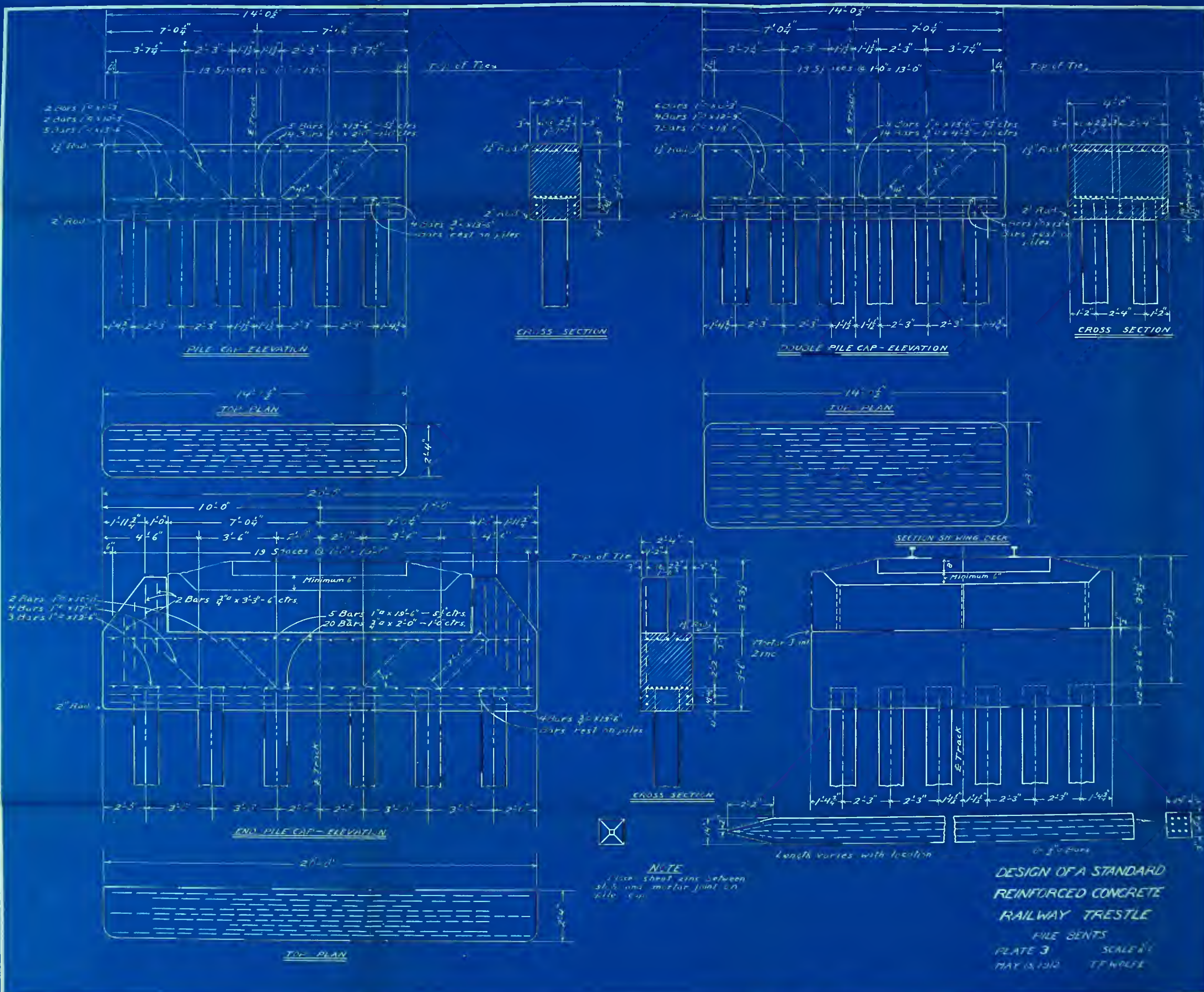
PLATE 1. SCALE 1"=3'

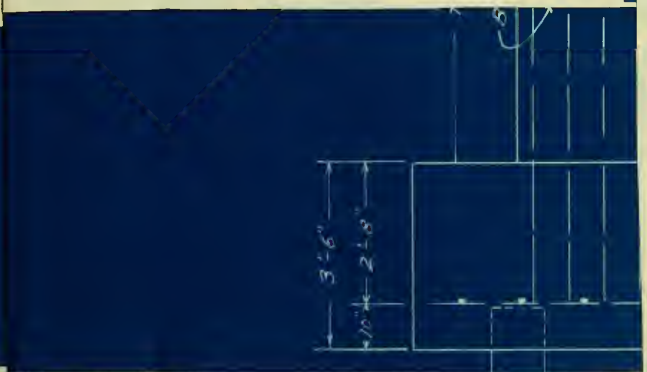
MAY 11 1912 T.F. WOLFE

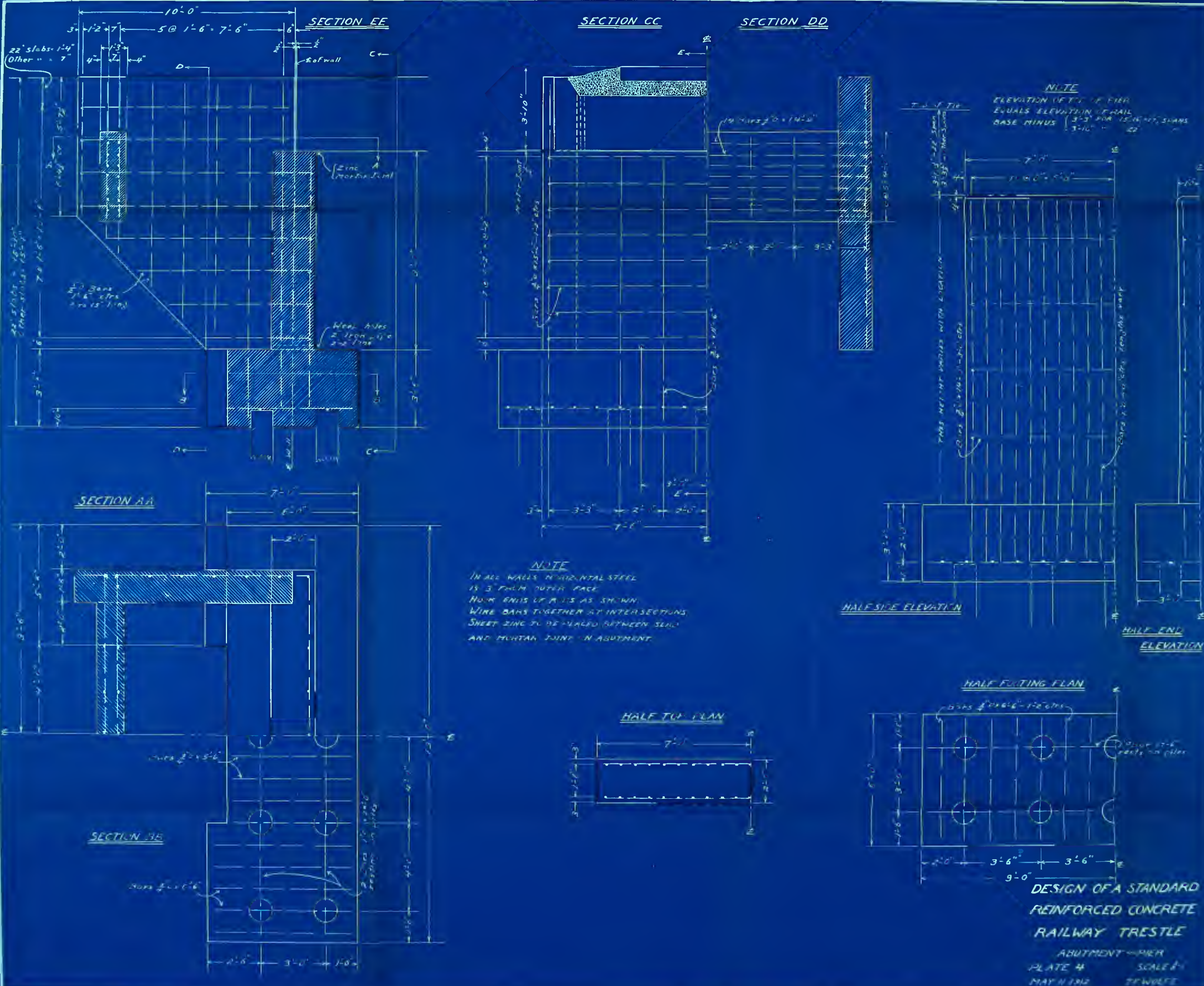

8'-0"
3'-11 3/4"
Drain
2" Dia


PLAN, ELEVATION, + SECTION OF 22' SLAB
Bend here
CROSS SECTION
21'-11½"
14'-0"
9 Spaces @ 2'-0" = 18'-0"
10'-10"
Drain holes 2x2"
17'-8"
Elevation of bar. All bars alike.
Bend up alternate ends.
PLAN ELEVATION + SECTION OF 15' SLAB
Bend here
Bars ¾" ɸ x 6'-8" 2'-0" ctrs
14'-11½"
9'-4"
6 Spaces @ 2'-0"
7'-5"
Drain holes 2x2"
PLAN, ELEVATION, + SECTION OF 16' SLAB
Bend here
Drain hole 2" diam.
Drain holes 2x2"
15'-11½"
PLAN, ELEVATION, + SECTION OF 17' SLAB
Bend here
Drain holes 2" diam.
16'-11½"
11'-0"
7 Spaces @ 2'-0" = 14'-0"
7'-5"
Drain holes 2x2"
LIFTING STIRRUPS
22' SLABS
15, 16 + 17' SLABS
#22 Galv. iron
FORM FOR DRAIN HOLES
NOTE
DISTANCE FROM BASE OF RAIL TO BOTTOM OF SLABS
22' SLABS = 3'-1½"
OTHER " = 3'-9½"
DESIGN OF A STANDARD
REINFORCED CONCRETE
RAILWAY TRESTLE
SLABS
PLATE 2
SCALE ⅛"
MAY 11, 1912
T.F. WOLFE

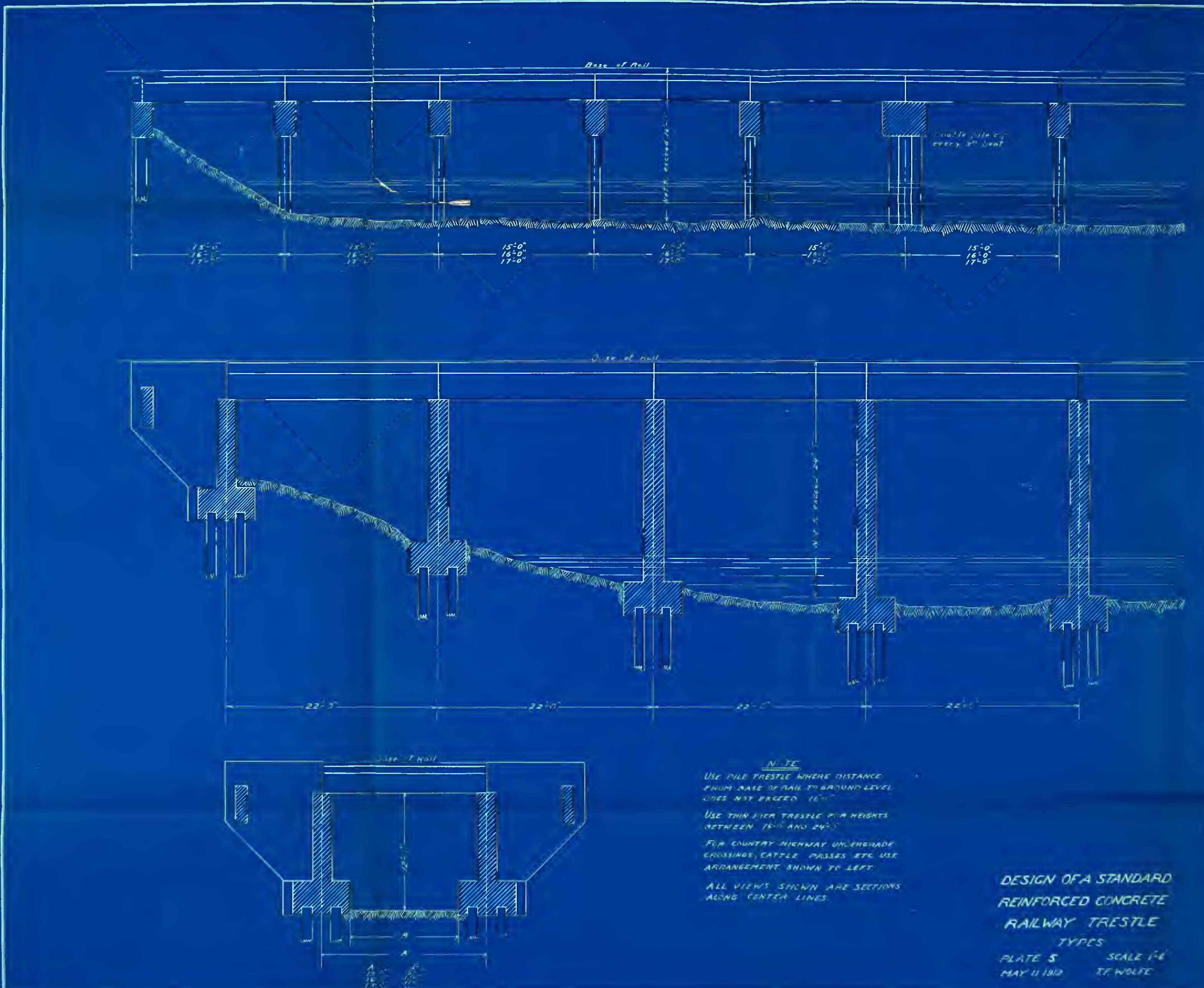

4'-8"
SECTION SHOWING DECK
8"
Minimum 6"


PILE CAP ELEVATION
CROSS SECTION
DOUBLE PILE CAP - ELEVATION
CROSS SECTION
TOP PLAN
TOP PLAN
END PILE CAP - ELEVATION
CROSS SECTION
SECTION SHOWING DECK
TOP PLAN
Top of Ties
Minimum 6"
2 Bars $\frac{3}{4}$" x 3'-3" - 6" ctrs.
5 Bars 1" x 19'-6" - $5\frac{1}{2}$" ctrs.
20 Bars $\frac{3}{4}$" x 2'-0" - 1'-0" ctrs.
4 Bars $\frac{3}{4}$" x 19'-6"
Bars rest on piles
Length varies with location
NOTE
Place sheet zinc between slab and mortar joint on pile cap.
DESIGN OF A STANDARD
REINFORCED CONCRETE
RAILWAY TRESTLE
PILE BENTS
PLATE 3
MAY 13, 1910
T.F. WOLFE


3'-6"
2'-8"
10"


SECTION EE
SECTION CC
SECTION DD
10'-0"
5 @ 1'-6" = 7'-6"
22" slabs = 1'-4"
Other " = 7"
℄ of wall
Zinc & Mortar Joint
Weep holes
NOTE
ELEVATION OF TOP OF PIER
EQUALS ELEVATION OF RAIL
BASE MINUS
3'-3" FOR 15-16 FT. SPANS
3'-10" " 22 "
SECTION AA
SECTION BB
NOTE
IN ALL WALLS HORIZONTAL STEEL
IS 3" FROM OUTER FACE
HOOK ENDS OF RODS AS SHOWN.
WIRE BARS TOGETHER AT INTERSECTIONS.
SHEET ZINC TO BE PLACED BETWEEN SLAB
AND MORTAR JOINT IN ABUTMENT.
HALF SIDE ELEVATION
HALF END ELEVATION
HALF TOP PLAN
HALF FOOTING PLAN
3'-6"
9'-0"
7'-0"
DESIGN OF A STANDARD
REINFORCED CONCRETE
RAILWAY TRESTLE
ABUTMENT — PIER
PLATE 4
SCALE
MAY 11 1912
T. F. WOLFE

Not to exceed 24'0"


Base of Rail
15'-0"
16'-0"
17'-0"
NOTE
USE PILE TRESTLE WHERE DISTANCE FROM BASE OF RAIL TO GROUND LEVEL DOES NOT EXCEED 16'-0"
USE THIN PIER TRESTLE FOR HEIGHTS BETWEEN 16'-0" AND 24'-0"
FOR COUNTRY HIGHWAY UNDERGRADE CROSSINGS, CATTLE PASSES ETC USE ARRANGEMENT SHOWN TO LEFT.
ALL VIEWS SHOWN ARE SECTIONS ALONG CENTER LINES.
DESIGN OF A STANDARD
REINFORCED CONCRETE
RAILWAY TRESTLE
TYPES
PLATE 5
SCALE 1"=6'
MAY 11 1912
T.F. WOLFE

1 ABUTMENT

NO.	SIZE	LENGTH	LOCATION
2	ALL ½"□ BARS	6'-0"	
2		7'-0"	
2		7'-9"	
2		9'-3"	VERTICAL IN SIDE
2		10'-9"	WALLS
2		11'-6"	
8		15'-3"	
6		9'-6"	
4		11'-0"	
2		10'-0"	HORIZONTAL IN SIDE
2		8'-9"	WALLS
2		8'-0"	
2		5'-3"	
8	¾"□	15'-0"	FRONT-HORIZONTAL
5	¾"□	11'-6"	" VERTICAL
14	½"□	14'-9"	DIAPHRAM
10	½"□	3'-6"	"
10	¾"□	6'-6"	FOOTING
9	¾"□	5'-6"	"
2	1"□	18'-6"	"
39.22 YDS OF CONCRETE			
1,217 LBS. STEEL BARS			

1 PIER

NO.	SIZE	LENGTH	LOCATION
15	¾"□	6'-6"	FOOTING
2	1"□	17'-6"	"
8	¾"□	14'-0"	HORIZONTAL IN PIER
42	1"□	VARIES	VERTICAL " "
CU. YDS. CONCRETE = 13.6 + 1.04 L			
LBS. STEEL = 519 + 142.5 L			
WHERE L = DISTANCE FROM TOP OF			
FOOTING TO TOP OF PIER.			

1 PILE CAP

NO.	SIZE	LENGTH	LOCATION
5	1"□	13'-6"	TOP
5	1"□	13'-6"	BOTTOM
2	1"□	8'-3"	" BENT
2	1"□	12'-9"	" "
4	¾"□	13'-6"	"
14	¾"□	2'-0"	TRANSVERSE
3.92 CU. YDS. CONCRETE			
760 LBS. OF STEEL BARS			

1 DOUBLE PILE CAP

NO.	SIZE	LENGTH	LOCATION
9	1"□	13'-6"	TOP
7	1"□	13'-6"	BOTTOM
6	1"□	8'-3"	" BENT
4	1"□	12'-9"	" "
4	¾"□	13'-6"	"
14	¾"□	4'-3"	TRANSVERSE
7.90 CU. YDS. OF CONCRETE			
1296 LBS. OF STEEL BARS			

1 END PILE CAP

NO	SIZE	LENGTH	LOCATION
5	1"□	19'-6"	TOP
3	1"□	19'-6"	BOTTOM
2	1"□	10'-0"	" BENT
4	1"□	17'-0"	" "
4	¾"□	19'-6"	"
20	¾"□	2'-0"	TRANSVERSE
8	¾"□	3'-3"	VERTICAL AT ENDS
6.1 CU. YDS. OF CONCRETE			
1172 LBS. STEEL BARS			

1-15' SPAN – 2 SLABS

NO	SIZE	LENGTH	LOCATION
16	⅞"□	14'-8"	BOTTOM
16	⅞"□	15'-9"	" BENT
14	⅞"□	15'-8"	" "
14	¾"□	6'-8"	" TRANS.
14	¾"□	3'-0"	SLANT. IN PARAPET
4	⅞"□	14'-8"	" "
15.5 CU. YDS. OF CONCRETE			
2247 LBS. OF STEEL BARS			

1-16' SPAN – 2 SLABS

NO.	SIZE	LENGTH	LOCATION
16	⅞"□	15'-8"	BOTTOM
16	⅞"□	16'-10"	" BENT
14	⅞"□	17'-1"	" "
16	¾"□	6'-8"	" TRANS.
16	¾"□	3'-0"	SLANT IN PARAPET
4	⅞"□	15'-8"	" "
173 CU. YDS. OF CONCRETE			
2280 LBS. OF STEEL BARS			

1-17' SPAN – 2 SLABS

NO.	SIZE	LENGTH	LOCATION
18	⅞"□	16'-8"	BOTTOM
18	⅞"□	18'-2"	" BENT
18	⅞"□	18'-0"	" "
16	¾"□	6'-8"	" TRANS.
16	¾"□	3'-0"	SLANT. IN PARAPET
4	⅞"□	16'-8"	" "
19.0 CU. YDS. OF CONCRETE			
2837 LBS. OF STEEL BARS			

1-22' SPAN – 2 SLABS

NO.	SIZE	LENGTH	LOCATION
66	⅞"φ	22'-4"	BOTTOM
20	⅞"φ	6'-8"	" TRANS.
20	¾"φ	4'-0"	SLANT. IN PARAPET
4	⅞"φ	21'-6"	IN PARAPET
31.4 CU. YDS. OF CONCRETE			
3540 LBS OF STEEL BARS			

1 FOOT OF PILE

.0505 CU. YDS. OF CONCRETE
6.8 LBS. OF ½"□ STEEL BARS

NOTE

CONCRETE IN FOOTINGS TO BE 1:3:5 OR 1⅜ BBLS. CEMENT TO EACH YARD OF CONCRETE.
CONCRETE IN ALL OTHER PARTS TO BE 1:2:4 OR 1¾ BBLS. OF CEMENT TO EACH YD. OF CONCRETE

DESIGN OF A STANDARD
REINFORCED CONCRETE
RAILWAY TRESTLE

BILL OF MATERIAL

PLATE 6 SCALE —

MAY 12 1912 T.F. WOLFE